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D216/D304

24.5200

AUTHORS: ~~Kudryashev, L. I.~~, Doctor of Technical Sciences, Professor, and Zhemkov, L. I., Aspirant

TITLE: The regular thermal regime in bodies with internal sources of energy for varying thermophysical properties

SOURCE: Kuybyshev. Industrial'nyy institut. Sbornik nauchnykh trudov. No. 8, 1959. Teplotekhnika; voprosy teorii, raschety i proyektirovaniya, 19-22

TEXT: In this paper, the authors extend their generalized theory of the regular thermal regime for varying coefficients of thermal conductivity and specific heat to the discussion of thermal emission by bodies with an internal heat source. The linearized version of the non-linear differential equation of thermal conductivity obtained by the authors in their generalized theory is

$$\frac{\partial \Phi}{\partial \xi} = \nabla^2 \Phi + q_v \qquad (1)$$

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where $\Phi = \int_0^i \frac{\lambda}{C_p} di$, $\xi = \int_0^\tau \frac{\lambda}{C_p \gamma} d\tau$, q_v is the internal source intensity per unit volume, λ the thermal conductivity, C_p the specific heat, γ the specific gravity, i the enthalpy, and τ the time variable. This equation is regular if

$$q_v = B\Phi_v \tag{2}$$

holds, where Φ_v is the average value throughout the volume of the body and B is a function of coordinates only. From these equations

$$\ln \Phi = - m'\xi + \text{const} \tag{7}$$

where

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$$m' = \frac{\ln \Phi_1 - \ln \Phi_2}{\xi_2 - \xi_1} \tag{8}$$

$B = \Phi$ corresponds to the regular thermal regime without a heat source, $B = m$ to a stationary regime, and the intermediate cases to different regimes of regular cooling. The case m = 0 corresponds to a constant body with ideal insulation, and the rate of heating or cooling is determined only by the intensity of the source or sink of heat and the thermophysical properties of the body. There are 3 Soviet-bloc references.

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24.5200

AUTHORS: ~~Kudryashev, L. I.~~, Doctor of Technical Sciences, Professor, and Zhemkov, L. I., Aspirant

TITLE: Generalization of G. M. Kondrat'yev's theorem to the case of varying coefficient of thermal conductivity and specific heat, and the use of the generalized theorem for determining the thermophysical properties of materials

SOURCE: Kuybyshev. Industrial'nyy institut. Sbornik nauchnykh trudov. No. 8, 1959. Teplotekhnika; voprosy teorii, raschety i proyektirovaniya, 23-29

TEXT: In this paper the restrictions that thermal conductivity λ and specific heat C_p should remain constant are removed from Kondrat'yev's theorem (Ref. 1: Regulyarnyy teplovoy rezhim. GTTI, 1954) dealing with the rate of cooling of a body. The first part of the theorem in the generalized case is essentially proved in the authors' generalized theory of the regular thermal regime. The

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second part, concerning the limiting value of the rate of cooling for an infinite coefficient of thermal emission from a body, is considered. The heat exchange equation in the linearized form obtained by the authors in the generalized theory may be written as

$$-\frac{\left(\frac{\partial \Phi}{\partial n}\right)_w}{\Phi_w} = \zeta \qquad (2)$$

where $\Phi = \int_0^i \frac{\lambda}{c_p} di$, i is the enthalpy, and the subscript w refers to the surface of the body. /-Abstractor's note: n and ζ are not defined._/ Here, the rate m_Φ of the change of Φ, with respect to ξ, where $\xi = \int_0^\tau \frac{\lambda}{c_p \gamma} d\tau$ and λ - specific gravity, τ = time, analogous

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to Kondrat'yev's rate of cooling, must have a finite value if the coefficient of thermal emission $\alpha_w \to \infty$. As an example, an infinite shell is considered, and from the solution of the linearized thermal conductivity equation obtained by the authors in the reference above, the limiting value of m_Φ becomes

$$m_\Phi \Big|_{\alpha_\omega \to \infty} = \left(\frac{\pi}{2X}\right)^2 = \text{const} \qquad (5)$$

/ Abstractor's note: X is not defined. / This ratio is the reciprocal of K, the coefficient of form first introduced by Kondrat'yev, and for any particular body this is also the case. This generalization of the second part of Kondrat'yev's theorem has a wide practical value. From (5), and using the relationship

$$\Phi = \int_0^i \frac{\lambda}{c_p}\, di = \int_0^i \gamma a\, di = \gamma \bar{a} i \qquad (8)$$

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Generalization of Kondrat'yev's

between Φ and the coefficient of temperature conductivity a, the limiting value of the rate of change of temperature with time is found to depend on

$$m_v\Big|_{\alpha_{W\to\infty}} = \frac{1}{t} \cdot \frac{\partial t}{\partial \tau} = - \frac{a}{K} \qquad (13)$$

and also the relation

$$m_v = - \frac{1}{t} \cdot \frac{\partial t}{\partial \tau} = m_{\Phi} a \qquad (15)$$

holds. m_{Φ} is a constant for each fixed value of thermal emission which may occur in an experiment, and is present only as a coefficient of proportionality. Kondrat'yev's theorem is, therefore, generalized for the case of any value of the coefficient of thermal X

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emission, and is much more effective than the theory of temperature regularity for studying the thermophysical properties of materials, in particular for determining the coefficient of temperature conductivity. There are 2 Soviet-bloc references.

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KUDRYASHEV, L.I., prof., doktor tekhn.nauk; TSERERIN, V.A., dotsent;
SYCHEV, M.Ya., inzh.

Theoretical bases for the derivation of equations for the hydrodynamic design of gas mains. Sbor. nauch. trud. Kuib. indus. inst. no.8:31-43 '59. (MIRA 14:7)
(Hydrodynamics) (Gas--Pipelines)

KUDRYASHEV, L.I., prof., doktor tekhn.nauk; TSEHERIN, V.A., dotsent

Effect of nonisothermal flow on the coefficient of hydrodynamic resistance in gas mains. Sbor. nauch. trud. Kuib. indus. inst. no.8:45-52 '59. (MIRA 14:7)

(Gas flow) (Gas--Pipelines)

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24.4300

AUTHORS: Kudryashev, L. I., Doctor of Technical Sciences, Professor, and Filippov, G. V., Candidate of Technical Sciences

TITLE: On the composite boundary layer at the entry region of a circular tube

SOURCE: Kuybyshev. Industrial'nyy institut. Sbornik nauchnykh trudov. No. 8, 1959. Teplotekhnika; voprosy teorii, rascheta i proyektirovaniya, 61-66

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TEXT: The authors consider the problem of the position of the transition point from laminar to turbulent flow for the boundary layer, and the effect of Reynolds number on the total coefficient of resistance. The coordinate of the transition point is determined using the idea of a critical Reynolds number and L. Shiller's theory of the laminary entry region. Assuming a parabolic velocity distribution in the boundary laminar layer at the entry,

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$$\frac{\bar{x}}{Re} = \frac{1}{4} f(\eta) \tag{1}$$

$$\bar{\delta}_1 = 2 - \sqrt{4 - 6 \frac{\eta}{1+\eta}} \tag{2}$$

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where

$$\eta = \frac{u - v_{av}}{v_{av}} ; \quad Re = \frac{v_{av} \cdot r_o}{}$$

where v_x = velocity in the boundary layer, U - velocity in the center of the flow, v_{av} - mean velocity [Abstractor's note: δ_1 undefined.]. The distance x from the center is relative to the radius of the tube r_o. The quantity Re_x is considered, where v_{av} and r_o

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are replaced by U and x respectively. Then, using Eq. (1), the value of Re_x at the point of transition is

$$Re_{x_t} = \frac{1}{4} f(\eta_t)(1 + \eta_t) Re^2 = \varphi(\eta_t) Re^2 \qquad (5)$$

Since the boundary layer is least stable in that cross-section where its thickness is greatest, and where the negative pressure gradient is a minimum, i.e. at the end of the entrance region, then through Shiller, $Re_{x_t} = 3.04 \cdot 10^5$. Thus, for a fixed Reynolds' number, the value of η_t may be determined, and the coordinate of the transition point x_t is given by

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$$x_t = \frac{3,04 \cdot 10^5}{Re(1+\eta_t)} \qquad (7)$$

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On the composite boundary ...

To determine the relative thickness of the laminar and turbulent boundary layers, the hypothesis of equality of thickness of momentum loss is used. This is determined for the laminar layer by

$$\bar{\delta}_{1_t}^{**} = 0.1333\,\bar{\delta}_{1_t} - 0.05\,\bar{\delta}_{1_t}^{2} \qquad (8)$$

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and analogously for the turbulent layer. Then, the overall length of the entry region and the field coefficient $K = v_{av}/U$ may be calculated. The total resistance coefficient λ_c is given by

$$\lambda_0 = \frac{p_0 - p}{\frac{\rho v_{av}^2}{2}} \cdot \frac{1}{d} \qquad (9)$$

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where l and d are the length and diameter of the tube, and p_0 and p are the pressures at the entry and end of the region considered /Abstractor's note: ρ undefined./. The ratio of this to the resistance coefficient for hydrodynamically stabilized motion for l less than the length of the entry region is calculated and for Re = 4000, this ratio is I. Increasing Re produces a sharp drop, reaching a minimum at Re = 5000. After this, the ratio rises slowly, reaching a limiting value analogous to the value for a purely turbulent boundary layer at the entry. For apparatus, in which the Reynolds number is close to the critical value, the authors recommend that the possibility of changing it during operation should be examined, since the total resistance coefficient depends strongly on it. Also, to increase the heat exchange apparatus, with the Reynolds number in the range 2,300 - 10,000, the flow at the inlet should be turbulent. There are 2 figures, 1 table and 3 Soviet-bloc references.

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26.5200

AUTHORS: Kudryashev, L. I., Professor, Doctor of Technical Sciences, and Devyatkin, B. A., Docent, Candidate of Technical Sciences

TITLE: The use of integral relations in determining coefficients of resistance and convective heat transfer for a confined medium

SOURCE: Kuybyshev. Industrial'nyy institut. Sbornik nauchnykh trudov, no. 8, 1959. Teplotekhnika; voprosy teorii, rascheta i proyektiravaniya, 67-82

TEXT: The paper begins with a discussion of the resistance and heat transfer in a tube of circular cross-section under the conditions of hydrodynamic and thermal stabilization and laminar flow. It is assumed that the liquid is incompressible and all the physical constants are independent of temperature. The hydrodynamic problem can be solved first and the heat-transfer problem second. Both solutions are known; the first was obtained by Stokes and the second by Lo-

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rentz, Academician L. S. Leybenzon and others. The authors attempt to solve the two problems with the aid of integral relations and obtained well-known formulae. The problem considered next is that of heat transfer under conditions of thermal stabilization. Considerations analogous to those described above lead to a dimensionless integral relation which can be used to determine the heat transfer coefficient. The distribution of the excess temperature is then sought in the form of a power series in r_1 and this is shown to give Nu = 6. The next problem is that of resistance and heat transfer under the conditions of stabilized turbulent motion in a tube of circular cross-section. The corresponding equations can be set up if it is assumed that the average motion of the liquid is axially symmetric (with respect to the longitudinal axis of the tube). The dimensionless integral relations for this case are deduced and a well known result is obtained for C_f. For a universal logarithmic velocity profile

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The use of integral ...

$$\frac{1}{\sqrt{C_f}} = 2 \cdot \lg(Re\sqrt{C_f}) + 0.8 \qquad (53)$$

is obtained. The fundamental relation of the hydrodynamic theory of heat transfer $Nu = C_f Pe/8$ is deduced as a special case. The above relation holds provided the effect of the boundary layer on the heat transfer coefficient is neglected. This means that a correcting coefficient $\underline{K}$ must be introduced into

$$Nu = \frac{C_f}{8} Pe \qquad (67)$$

to allow for this discrepancy, i.e.

$$Nu = \frac{C_f}{8} \cdot Pe \cdot K \qquad (68)$$

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The use of integral ...

The paper is concluded with a derivation of an approximate formula for the correction coefficient $\bar{K}$. The following model is employed: Turbulent heat transfer plays a decisive role in turbulent motion everywhere except for the laminar boundary layer near the wall. In the laminar boundary layer, the most important effect in the stress transfer is viscous friction, while the most important effect in the heat transfer is thermal conductivity. It then follows that the thickness of the hydrodynamic boundary layer is different from the thickness of the thermal boundary layer. In the turbulent region, the effect of the physical properties of the medium on the turbulent heat transfer is very small. Subject to various approximations, it is shown that

$$\bar{K} = Pr^{-\frac{n+1}{2}} \tag{104}$$

The average value of n is 0.1335. If the numbers vary between 10^4

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and 10^6, Eq. (53) can be replaced by

$$C_f = \frac{0,187}{Re^{0,2}} \qquad (106)$$

and then

$$Nu = 0,0234 \cdot Re^{0,8} \cdot Pr^{0,434} \qquad (107)$$

This gives satisfactory agreement with the empirical relation

$$Nu = 0.023 \cdot Re^{0,8} \cdot Pr^{0,43} \qquad (108)$$

which was derived by Academician M. A. Mikheev (Ref. 2: Osnovy teploperedachi (Fundamentals of Heat Transfer) (1949)). There are 1 figure and 2 Soviet-bloc references.

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32271

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AUTHORS: ~~Kudryashev, L. I.~~, Doctor of Technical Sciences, Professor, and Vvedenskaya, L. A., Candidate of Technical Sciences

TITLE: On determining the effect of free motion on the coefficient of heat transfer in forced flow past solids

SOURCE: Kuybyshev. Industrial'nyy institut. Sbornik nauchnykh trudov, no. 8, 1959. Teplotekhnika; voprosy teorii rascheta i proyektirovaniya, 131-143

TEXT: Experiments carried out by the authors have shown that free motion has an appreciable effect on convective heat transfer in the case of forced flow past solid bodies for relatively large Reynolds numbers. The paper is concerned with the theory of the phenomenon. The stationary problem of convective heat transfer is taken to be defined by the following equations:

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$$(w\nabla)w = F - \frac{1}{\rho}\,\mathrm{grad}\; p + v\nabla^2 w$$

$$\mathrm{div}\; w = 0$$

$$(w\nabla)t = a\nabla^2 t \qquad (2)$$

where w is the velocity vector, t the excess temperature of the flow, p the pressure, ρ the density of the medium, v the kinematic viscosity of the medium, a the temperature diffusity of the medium and F the lift force given by

$$F = g\frac{T - T_f}{T_f} = \beta\Delta t \qquad (3)$$

where T is the absolute temperature at any point in the field, T_f

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is the absolute temperature at a very distant point and g is the acceleration due to gravity. These equations are then reduced to a dimensionless form, and an estimation is obtained from them for the lower limit of the effect of free motion on the coefficient of convective heat transfer. The method employed is the superposition method which was developed by the present authors and which is used in conjunction with the theory of similarity. The theory has been checked by measuring the heat transfer coefficient under the conditions of forced convection for pipes of circular, square and triangular cross-section in wind tunnels. Both the theoretical and experimental results indicate that for $Re \leq Gr$ the effect of free convection is appreciable and must not be neglected. For a circular tube

$$Nu = 0.0563\ Re^{0,714} + 0,54(Gr \cdot Pr)^{0,25} \qquad (27)$$

The first term in this expression represents forced convection. For a tube of square cross-section

$$Nu = 0{,}0069\ Re^{0{,}91}\left[1 + 78{,}3\ \frac{(Gr \cdot Pr)^{0{,}25}}{Re^{0{,}91}}\right] \qquad (34)$$

(parallel orientation) and

$$Nu = 0{,}0063\ Re^{0{,}93}\left[1 + 85{,}8\ \frac{(Gr \cdot Pr)^{0{,}25}}{Re^{0{,}93}}\right] \qquad (35)$$

(perpendicular orientation, one edge facing the stream). Finally, for a tube of triangular cross-section the result is

$$Nu = 0{,}051\ Re^{0{,}69}\left[1 + 10{,}6\ \frac{(Gr \cdot Pr)^{0{,}25}}{Re^{0{,}69}}\right] \qquad (37)$$

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$$Nu = 0,0525\ Re^{0,69}\left[1 + 10,3\ \frac{(Gr \cdot Pr)^{0,25}}{Re^{0,69}}\right] \quad (38)$$

where the former applies to the parallel orientation and the latter to the perpendicular orientation (edge or side facing the stream). There are 5 figures and 6 Soviet-bloc references.

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KUDRYASHEV, L.I., prof., doktor tekhn.nauk; NOVICHKOVA, O.G., inzh.

Theoretical bases for evolving an equation to determine the coefficient of hydraulic resistance inside circular tubes in the case of markedly nonisothermal flow. Sbor. nauch. trud. Kuib. indus. inst. no.8:167-172 '59. (MIRA 14:7)
(Differential equations) (Hydrodynamics)

KUDRYASHEV, L.I., prof., doktor tekhn.nauk; BEREZANSKIY, V.Yu., kand. tekhn.nauk

Effect of unsteady thermal conditions and flow rates on convective heat transfer in gaseous dispersive systems. Sbor. nauch. trud. Kuib. indus. inst. no.8:185-188 '59. (MIRA 14:7)
(Heat--Convection) (Hydrodynamics)

KUDRYASHEV, L.I., prof., doktor tekhn.nauk; BEREZANSKIY, V.Yu., kand. tekhn.nauk

Effect of free convection on convective heat transfer in gaseous dispersive systems. Sbor. nauch. trud. Kuib. indus. inst. no.8: 189-196 '59. (MIRA 14:7)

(Heat--Convection) (Hydrodynamics)

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26. 5200

AUTHORS: Kudryashev, ~~L. I.~~, Professor, Doctor of Technical Sciences, and Romeyko, N. P., Engineer

TITLE: Simultaneous application of the method of intermediate integration and the theory of similarity to solving problems of convective heat transfer

SOURCE: Kuybyshev. Industrial'nyy institut. Sbornik nauchnykh trudov, no. 8, 1959. Teplotekhnika; voprosy teorii, rascheta i proyektirovaniya, 197-205

TEXT: The authors are concerned with heat transfer in a confined medium. They show that whatever the flow conditions, both the resistance and heat transfer are determined by the temperature conditions at the wall. Existing theories of heat transfer in a confined medium are critically examined, and the theory of similarity is used to reformulate the problem in the case of turbulent flow. It is shown that the method of "intermediate integration" leads to the following expressions which are universal both for turbulent

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Simultaneous application of ...

and laminar flow in a confined medium:

$$\bar{\gamma}\,\bar{c}_p\bar{w}\,\frac{\overline{\partial t}}{\partial z} = \frac{2}{r_o}\,\lambda_w\left(\frac{\partial t}{\partial r}\right)_{r = r_o} \qquad (a)$$

$$\frac{\partial p}{\partial z} = \frac{2}{r_o}\mu_w\left(\frac{\partial w}{\partial r}\right)_{r = r_o} \qquad (b) \qquad (12)$$

It is established that the formulae giving the coefficients of heat transfer and resistance should include the ratios of the viscosity and thermal conductivity at the wall and in the stream, rather than the ratio of the Prandt numbers. It is shown that determination of the coefficients of heat transfer and resistance can be reduced to determining the radial derivatives of the tem- X

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Simultaneous application of ...

perature and velocity at the wall of the tube

$$\left(\frac{\partial t_1}{\partial r_1}\right)_{r_1=1} = C_1 Re_f^{n_1} Pr_f^{n2} \left(\frac{\lambda_{10}}{\lambda}\right)^{n3} \tag{34}$$

$$\left(\frac{\partial w_1}{\partial r_1}\right)_{r_1=1} = C_2 Re_f^{m_1} \left(\frac{\mu_w}{\mu}\right)^{m2} \tag{35}$$

as functions of $\mu_w/\bar{\mu}$ and $\lambda_w/\bar{\lambda}$ [Abstractor's note: No explicit definition of symbols given.].

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KUDRYASHEV, L.I., prof., doktor tekhn.nauk; SHCHEBRAYEV, Ye.V., inzh.

Designing a heating panel by the method of equivalent cylindrical walls. Sbor. nauch. trud. Kuib. indus. inst. no.8:207-210 '69. (MIRA 14:7)

(Thermodynamics) (Radiant heating)

KUDRYASHEV, L.I., prof., doktor tekhn.nauk; DEVYATKIN, P.A., dotsent, kand.tekhn.nauk; BEREZANSKIY, V.Yu., kand.tekhn.nauk; GOLOVANOV, O.M., kand.tekhn.nauk

Improving boiler rating and steam quality at the boiler plant of the "Magnezit" works. Sbor. nauch. trud. Kuib. indus. inst. no.8:231-238 '59. (MIRA 14:7)

(Boilers)

KULRY/JHEV, L.I., prof., doktor tekhn.nauk; FREYDIN, A.S., dotsent

Determination of the hydraulic resistance and heat transfer in turbulent air flow in noncircular tubes. Sbor. nauch. trud. Kuib. indus. inst. no.8:293-299 '59. (MIRA 14:7)
(Heat--Transmission) (Hydrodynamics)

ODEL'SKIY, E.Kh., prof., doktor tekhn.nauk; KUDRYASHOV, L.I., prof. doktor tekhn.nauk

Hydrodynamic investigations of tubular cyclone combustion chambers. Sbor. nauch. trud. Bel. politekh. inst. no.74:100-114 '59. (MIRA 13:8)

(Furnaces) (Gas flow)

KUDRYASHEV, L.I.; SYCHEV, M.Ya.

Approximative method of integrating gas dynamic equations in calculating gas pipelines. Izv. vys. ucheb. zav.; n ft' i gas 3 no.1:107-113 '60. (MIRA 14:10)

1. Kuybyshevskiy industrial'nyy institut im. V.V. Kuybysheva. i Kuybyshevskiy aviatsionnyy institut.
(Gas, Natural--Pipelines)

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E022/B420

10.2000
26.2182

AUTHORS: Kudryashev, L.I. and Golovin, V.M.

TITLE: The Influence of the Dissipation of Mechanical Energy on the Coefficient of Hydraulic Resistance and on the Flow Rate Through Narrow Ducts in the Laminar Flow Regime

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Aviatsionnaya tekhnika, 1960, No.3, pp.3-11

TEXT: A quantitive assessment is made of the influence of the dissipation of mechanical energy in the laminar flow of liquids through narrow ducts whose length ℓ is so large compared with the height 2h that the contribution of the initial portion of the duct to the total flow resistance may be considered as negligible. The equations of motion, continuity and energy for the laminar non-isothermal flow are given in vectorial form by Eq.(1), in which most of the symbols have their usual meaning except I, which is the mechanical equivalent of heat, and $\dot{S}$, which is the tensor of the rate of deformation of the fluid. Assuming that the velocity vector $\bar{v}$ satisfies the condition of Eq.(3), then it can be expressed by the relation of Eq.(2); by considering only

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The Influence of the Dissipation of Mechanical Energy on the Coefficient of Hydraulic Resistance and on the Flow Rate Through Narrow Ducts in the Laminar Flow Regime

stationary problems and neglecting the body forces $\bar{F}$, Eq.(1) can be transformed into Eq.(5). Although Eq.(5) appear more involved than Eq.(1), they are, however, more tractable as regards both the admission of simplifying assumptions for their solution and the analysis of these solutions. In particular, Eq.(5) facilitate the selection of problems which can be solved by means of separation of variables. Some 2-dimensional flows are then considered which satisfy Eq.(2). First, the flow is studied in a narrow duct, with the axis of symmetry along x-axis, when the temperature of the bottom wall T_{w1} is different from that of the top wall T_{w2}, and the conditions are sought which would make the flow to be a function of pressure p only. It is shown that such a flow is possible only at some distance downstream from the entry section, i.e. where the flow is stable. Next, the problem of dissipation of mechanical energy in the region of this stable flow is tackled under the assumption that the temperatures of both walls are equal and the pressure gradient along the duct is constant.

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The Influence of the Dissipation of Mechanical Energy on the Coefficient of Hydraulic Resistance and on the Flow Rate Through Narrow Ducts in the Laminar Flow Regime

Eq.(1) transform then to Eq.(8) with boundary conditions as in Eq.(9). Assuming further that the temperature gradient between the walls and the fluid is not large ($\Delta T \approx 10°C$) and that the temperatures of the liquids used in practice (water, oil, spirits, lubricants etc.) are of the order of 20 to 100°C, then - as shown in Ref.2 and 3 - the viscosity may be expressed by Eq.(10) or (11), where μ_w is the viscosity at the wall temperature T_w, while the thermal conductivity may be considered as constant, i.e. $\lambda = \lambda_w$. With these assumptions, Eq.(8) may be integrated as shown on p.7, giving eventually the velocity of the flow in Eq.(18) and the rate of flow in Eq.(19) or Eq.(20). These results are then compared with the known classical solutions, Eq.(21), and it is shown that the two results are identical in the limit, i.e. when $Re_1 \to 0$, (Eq.(26)). Finally, the coefficient of resistance is evaluated. This is done by taking into account the change in the mean velocity of the flow produced by the change in

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The Influence of the Dissipation of Mechanical Energy on the Coefficient of Hydraulic Resistance and on the Flow Rate Through Narrow Ducts in the Laminar Flow Regime

the viscosity of the fluid, when compared with the mean velocity as resulting from Eq.(21). This leads to Eq.(29), (30) and (31), the last formula being the actual correction due to dissipation of the mechanical energy. There are 1 figure and 4 Soviet references (one is a translation into Russian of Janke and Emde's tables).

ASSOCIATION: Kuybyshevskiy aviatsionnyy institut Kafedra aerogidrodinamiki (Kuybyshev Aviation Institute, Chair of Aero- and Hydrodynamics)

SUBMITTED: February 29, 1960

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26.2160

AUTHORS: Kudryashev, L.I. and Kopotev, A.A.

TITLE: Theoretical and Experimental Investigation of the Influence of Instability on the Flow Through Nozzles

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Aviatsionnaya tekhnika, 1960, No.3, pp.65-73

TEXT: The present mathematical analysis is based on the theory expounded by Stanyukovich (Ref.3 and 4). The motion being assumed one-dimensional, the equations governing the unsteady flow of a compressible gas are as in Eq.(1), in which w is velocity, t is time and the other symbols have their usual meaning. These equations may be transformed to read as in Eq.(2) of which the first relation may be integrated, the result being Eq.(8). If the magnitude of w_1 is small compared with w_2, this last relation may be reduced to that of Eq.(9). For the case of steady motion, the corresponding relation is given by Eq.(10). From Eq.(9) and (10), Eq.(11) is obtained. From Eq.(11) it is seen that for the same value of p_2/p_1, the instantaneous velocity in the case of unsteady flow through a nozzle is always higher than the corresponding velocity in steady flow, because $(2\Phi)/(w_2^2)$ is

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always a positive quantity. The corollary to this result must be that in an unsteady flow it is possible to obtain the same velocity as that in a steady flow, even with a somewhat lower pressure ratio p_1/p_2 than that required in the case of steady flow. A similar relation holds also for the critical velocity of the flow. If the flow is adiabatic, the energy equation is Eq.(12) which, when transformed into Eq.(13), can be integrated and thus leads to Eq.(15) or (17). Again if w_1 may be neglected when compared with w_2, the relation simplifies to Eq.(18). As for the critical velocity, a^*, this is given by Eq.(19), from which it is seen that because of unsteadiness of the flow the velocity in the subsonic region may attain a higher value than the corresponding critical velocity in the case of steady flow. All these relations do not take into account any frictional losses or entry losses. When these are included, the efflux velocity will be somewhat lower. These losses may be accounted for by velocity coefficients. Consider now the instantaneous dynamic impulse Eq.(20) (F_c being the exit

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area of the nozzle) and relate it to Eq.(11) to obtain Eq.(21). Again the magnitude of the momentum in unsteady flow is larger than its value in the corresponding steady flow. Hence it appears that a turbine working with pulsating pressure may be more effective than a similar turbine working under constant pressure. In practice, the mean values (over a period) are of greater interest than the instantaneous values. Thus considering the mass flow G, it may be expressed in terms of mean values of density and velocity as shown in Eq.(24), and hence the mean value of the momentum is given by Eq.(28). In order to verify these relations, some experiments were carried out on a single-cylinder, four-stroke, air-cooled engine (based on M-11 engine) whose design data are as follows: diameter - 125 mm, stroke - 140 mm, swept volume - 1.72 litres, compression ratio - 5, speed - 1600 rpm, maximum rate of air flow - 75 kg/sec. The exhaust was directed into a tube 500 mm long, to the end of which various nozzles were attached (see Fig.1 and 4). The flow was measured by means of a pulsometer, described in Ref.7, which permits the measurement of the

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instantaneous values of the momentum and also shows their variations on an oscillograph. Simultaneous pressure readings were taken in the tube upstream of the nozzles and in the engine cylinder, and in addition the rate of flow of the air supplied to the engine, the fuel consumption and the power output were measured. The results of these experiments are shown in Fig.2 and 3. The experimental data were then related to the theoretical analysis. For example, in order to determine the function $\Phi(\tau)$ (defined by Eq.(7)) pressure diagrams $p = p(\tau)$ were plotted (Fig.1, top diagram) from which by means of graphical differentiation $\partial p/\partial \tau$ were obtained. These were then divided by the corresponding values of $\rho = \rho(\tau)$ and the graph so obtained (middle graph in Fig.2) was integrated graphically to produce $\Phi(\tau)$ (bottom graph in Fig.2). Similarly, by relating the theoretical value of $(w_2/w_0)^2$ with the corresponding experimental data, the velocity coefficient $\varphi = (w_{2g})/(w_2)$, i.e. the ratio of the actual efflux velocity to the theoretical efflux velocity, was obtained. This is shown

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in Fig.3. Finally, from the graphs of instantaneous values over a period T, the mean values of various quantities quoted in Table 1 were deduced. There are 4 figures, 1 table and 7 Soviet references.

ASSOCIATION: Kuybyshevskiy aviatsionnyy institut Kafedra aerogidrodinamiki (Kuybyshev Aviation Institute, Chair of Aero- and Hydro-Dynamics)

SUBMITTED: January 14, 1960

Card 5/5

KUDRYASHEV, L.I.; TSEREMIN, V.A.; SYCHEV, M.Ya.

Basic gas dynamic modeling of gas pipelines. Izv. vys. ucheb. zav.; neft' i gaz 3 no.3:103-106 '60. (MIRA 14:10)

1. Kuybyshevskiy industrial'nyy institut imeni V.V.Kuybysheva i Kuybyshevskiy aviatsionnyy institut.
(Gas, Natural--Pipelines) (Gas dynamics)

KUDRYASHEV, L.I.; TSEREBIN, V.A.

Using the gas dynamic theory of modeling in the experimental determination of the gas dynamic resistance of gas pipelines. Izv.vys.ucheb.zav.; neft' i gaz 3 no.6:119-121 '60. (MIRA 13:7)

1. Kuybyshevskiy industrial'nyy institut im. V.V.Kuybysheva. (Gas, Natural--Pipelines)

88240

S/152/60/000/012/006/007
B027/B063

10.2000

AUTHORS: Kudryashev L. I., Golovin V. M.

TITLE: Effect of Dissipation of Mechanical Energy on the Hydraulic Resistance Coefficient for Laminar Flow in Tubes With Circular Cross Sections

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Neft' i gaz, 1960, No. 12, pp. 105 - 112

TEXT: It is frequently necessary to determine the resistance to laminar flow in long pipelines. Heating of the liquid by internal friction may be rather important, if a highly viscous product is concerned. Hence, it is necessary to determine quantitatively the effect of mechanical energy dissipation on the output of the pipe, and the resistance coefficient. In this paper, an attempt referring to this is described, since this problem has not yet been solved, with the exception of some general data given by the academicians V. G. Shukhov and L. S. Leybenzon. A number of equations was established, from which follows that the classical Stokes solution is

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S/152/60/000/012/006/007
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a first approximation. The calculations show that the effect of the mechanical energy dissipation on the throughput and the resistance coefficient is the greater, the smaller the pipe diameter and the more viscous the fluid. Thus, the throughput of the pipe may be increased by 10 to 15%. The effect of energy dissipation may be, therefore, calculated from equations 30 and 31, respectively:

$$\frac{Q}{Q_1} = \frac{2}{\xi} \cdot \frac{J_1(\xi)}{J_0(\xi)} \quad (30); \qquad D = \left[\frac{\xi J_0(\xi)}{2J_1(\xi)}\right]^2 \quad (31).$$

Q = throughput, $\xi = 0.5\, m\, R^2 = ARe_1$ (R = radius of the pipe), $m^2 = (\delta/4J\lambda_w\mu_w)\,(dp/dz)^2$; $\delta = 0.1\left[\mu_w/\mu_{T_{w+10^\circ C}} - 1\right]$; μ_w = viscosity at the

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temperature T_w of the tube-wall; λ_w - heat conductivity at T_w; J - mechanical heat equivalent; $D = 1/4 \left[1 - J_1'(ARe_1)/J_o(ARe_1)\right]^2$ is the correction for energy dissipation; $A = n(\mu_w)^2/\varsigma_w R$; Re_1 - Reynolds number. The authors further develop the suggested solution with respect to various liquids and non-isothermal flow. There are 1 figure and 3 Soviet references.

ASSOCIATION: Kuybyshevskiy aviatsionnyy institut (Kuybyshev Aviation Institute)

SUBMITTED: February 23, 1960

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DZHEVUL'SKIY, V. A

KUDRYASHEV, L. I., and ~~DZEVUL'SKI, V. A.~~

"On the Proof of the Thermal Regularity Existance in a Boundary Layer at Regularity in a Turbulent Nucleus of a Flow and Vice Versa."

Report submitted for the Conference on Heat and Mass Transfer, Minsk, BSSR, June 1961.

KUDRYASHEV, L. I, and SHCHIBRAYEV, E. V.

"Heat and Transfer at a Jet Flow Round Bodies."

Report submitted for the Conference on Heat and Mass Transfer, Minsk, BSSR, June 1961.

KUDRYASHEV, L. I. and TEMNIKOV, A. V.

"Investigation of Non-linear Problems of non-stationary Heat Transfer by Electrical Modeling Method.

Report submitted for the Conference on Heat and Mass Transfer, Minsk Bssr, June 1961.

KUDRYASHEV, L. I., and GUSEV, I. A.

"Influence of Velocity Instability of an Infinite Flow on Heat Transfer Coefficient at the Flowing of Bodies."

Report submitted for the Conference on Heat and Mass Transfer, Minsk, BSSR, June 1961.

20593

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S/147/61/000/001/002/016
E022/E135

AUTHORS: Kudryashev, L.I., and Golovin, V.M.

TITLE: On the Solution of Stability of the Laminar Flow of Viscous Fluids Flowing Between Flat Parallel Walls

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Aviatsionnaya tekhnika, 1961, No. 1, pp. 13-18

TEXT: The problem of stability of the laminar flow has attracted much research which indicates its importance both theoretically and practically. In spite of so much effort being spent on the problem it is not fully solved as yet, (Ref.1). The reason is the great mathematical complexity of the problem. Various simplifications made by some authors in order to enable this problem to be solved are sometimes questionable. One of the main shortcomings of the theoretical analysis of the problem is that in most cases heat transfer with the surroundings, as well as the heat effect produced by internal friction, are neglected. However, these two effects influence physical properties of the fluid and therefore the flow of the fluid must also be affected. It is basically erroneous to assume that these effects are

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On the Solution of Stability of the Laminar Flow of Viscous Fluids Flowing Between Flat Parallel Walls

negligible especially at higher velocities and at large Reynolds number values, when dealing with the stability of the laminar flow. The present work has as its object the evaluation of the effect of these factors, and for that reason the basic equations of motion include dependence of the physical parameters of the fluid on the temperature:

$$\rho\frac{d\bar{v}}{dt} = \rho\bar{F} - \text{grad } p + \mu\Delta\bar{v} + 2\text{grad } \mu\cdot\dot{S} + \frac{1}{3}\mu \text{ grad div } \bar{v} - \frac{2}{3}\text{ div } \bar{v} \text{ grad } \mu, \tag{1}$$

$$\frac{d\rho}{dt} + \rho \text{ div } \bar{v} = 0 \tag{2}$$

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$$I\rho C_v \frac{dT}{dt} = I\ \mathrm{div}(\lambda\ \mathrm{grad}\ T) - p\ \mathrm{div}\ \bar{v} + 2\mu \cdot \dot{S} - \frac{2}{3}\mu(\mathrm{div}\ \bar{v})^2 \qquad (3)$$

where the symbols have their usual meaning, except: I - mechanical equivalent of heat; S - tensor of the velocity of deformation; $\lambda(T)$ - coefficient of heat conductivity. Employing the small perturbation method, the authors distinguish viscous and non-viscous instability at high Reynolds numbers. In the case of non-viscous instability the arguments of Lord Rayleigh (Ref.3) and W. Tollmien (Ref.4), viz. that the necessary and sufficient condition of non-viscous instability in a symmetric flow is simply the existence of the point of inflection in the velocity profile, still hold true. Stable solution of the system of Eqs. (1) to (3) for the flow between two flat parallel plates is dealt with in earlier work of the authors (Ref.5). In the present paper the authors extend the analysis by superimposing on the stable flow small disturbances and utilize the Rayleigh—

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Tollmien criterion for the non-viscous instability. They arrive at the conclusion that the instability develops at some large value of Reynolds number, which is the upper critical Reynolds number, as given by:

$$\frac{3}{2}\left[\frac{\left(\frac{Pr_w}{Pr_{T_w}+T_w} - 1\right)Pr_w}{K_{\Delta T}\,{}^{\circ}C\;Ga_w}\right]^{\frac{1}{2}} \cdot Re_1 \geqslant 0.807 \qquad (15)$$

where Pr = Prandtl number; Ga - Gallilleo number, $K_{\Delta T}\,{}^{\circ}C$ - specific gradient of heat content.

There are 2 figures and 5 references: 2 Soviet and 3 non-Soviet.

ASSOCIATION: Kuybyshevskiy aviatsionnyy institut, Kafedra aerodinamiki (Department of Aerodynamics, Kuybyshev Aviation Institute)

SUBMITTED: July 1, 1960

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S/152/61/000/003/003/003
B129/B201

AUTHORS: Kudryashev, L. I., Golovin, V. M.

TITLE: Problem of the stability of the laminar motion of a viscous liquid in circular cylindrical pipes

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Neft' i gaz, no. 3, 1961, 107-112

TEXT: The authors studied the effect of the dissipative heating and heat exchange with the surrounding medium upon the stability of the laminar flow of a viscous liquid in circular cylindrical pipes. Using the theorem by Rayleigh-Tollmien, the nonviscous instability of the flow with respect to the hydrodynamic and thermal stabilization is shown, and the criterional inequality for the determination of the highest critical Reynolds' number is given. The problem of the stability of the laminar motion and its transition into turbulent motion is of theoretical and of practical importance. The explanation of all factors having an effect upon the stability of the laminar motion in one or the other direction is of importance both for the further elaboration of theoretical bases and also directly from

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the technical viewpoint, as it is associated with the possibility of reducing energy losses in the transport of liquids and gases. Therefore, a great number of theoretical and experimental studies has appeared since the publication of the first paper by O. Reynolds. Although the authors do not have the possibility, within the scope of the present paper, of dealing extensively with the consideration and the evaluation of the various papers, investigation methods, and results obtained, it is possible, however, to note certain deficiencies, which are quite essential, in their opinion, in the formulation of the problem. One may see from the mathematical formulation of the task that in most cases insufficient attention is devoted to the problems of the heat exchange of the liquid with the surrounding medium, its heating at the expense of the dissipation of the mechanical energy, and thus, of the change of its physical parameters with temperature. At the same time, this change is bound to have a considerable effect upon the characteristic of the motion. If neglecting these factors in the study of the motion with not too high Reynolds' numbers is still somehow justified, it is no more so in the analysis of the stability of a longer lasting laminar motion, especially as regards the problem of the presence of the highest critical Reynolds number. From this

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viewpoint the present work may be of some interest, inasmuch as the attempt is made to take into account the effect of the abovementioned factors. The authors have used formulas to examine the relationships between temperature, velocity, heat exchange, etc. between the liquids (petroleum, alcohols, water). Conclusions: Basing on the use of the total system of equations of hydrodynamics and heat exchange, and also of the theorems by Rayleigh-Tollmien, the authors show the nonviscous instability of the flow in the stabilized part (in hydrodynamic and thermal respects) of the circular cylindrical pipe, starting with a rather high upper critical Reynolds number. The criterional equation for the determination of the highest critical Reynolds number is given. There are 6 references: 1 Soviet-bloc and 5 non-Soviet-bloc.

ASSOCIATION: Kuybyshevskiy industrial'nyy institut imeni V. V. Kuybysheva (Kuybyshev Industrial Institute imeni V. V. Kuybyshev)

SUBMITTED: July 6, 1960

S/147/61/000/004/013/021
E025/E120

26 5200

AUTHORS: Kudryashev, L.I., and Lyakhov, V.K.

TITLE: Calculation of the effect of longitudinal non-isothermalness on the heat transfer coefficient in the conditions of the internal problem

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Aviatsionnaya tekhnika, no.4, 1961, 104-110

TEXT: If for hydraulic smooth tubes a known pattern of turbulent flow is assumed, then the problem of determining the heat transfer coefficient can be reduced to a system of differential equations for the boundary layer. The equations are reduced to a simpler form, because the boundary layer is very thin; by assuming mean values for a number of parameters, and that the velocity and temperature satisfy power laws in the tube. An approximation is obtained for the local value of the Nusselt criterion and the mean value of the Nusselt number is calculated for the tube. A general form is given for the mean Nusselt number showing that if the physical parameters are determined for the mean temperatures of the flow and the heat transfer

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coefficient is also referred to the mean temperature then a correction must be introduced to take account of longitudinal non-isothermalness. These results were tested experimentally. The experiments were carried out for various amounts of longitudinal non-isothermalness from 2 to 30 °C. Diesel oil was used as the working liquid. The experimental results for heating and cooling are compared with a well known experimental formula and are in substantial agreement with it. However, there is a scatter of experimental points which is too great to be accounted for by experimental errors. Moreover, this scatter is a function of the temperature and parameters of the tube. On the other hand, by using separate equations for heat transfer on heating and cooling the scatter of points does not exceed 8% and this agrees with the formula derived from theoretical considerations. It is shown that the spread of the points is substantially decreased by taking account of non-isothermalness and a simple method of estimating the effect of longitudinal non-isothermalness is proposed for practical calculations.

There are 4 figures.

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ASSOCIATION: Kafedra aerogidrodinamiki, Kuybyshevskiy aviatsionnyy institut
(Department of Aerohydrodynamics, Kuybyshev Aviation Institute)

SUBMITTED: August 6, 1960

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S/152/61/000/001/007/007
B023/B064

AUTHORS: Kudryashev, L. I., Tsererin, V. A.

TITLE: Effect of the non-steady state of flow upon the coefficient of the gas-dynamic resistance of gas mains

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Neft' i gaz, no. 7, 1961, 105-112

TEXT: Usually the case of a steady gas flow is assumed in planning and working of gas mains, while in practice non-steady flow occurs as a result of the change of consumption per unit time. It is therefore possible to apply the equations obtained for the steady flow to the analysis of gas-dynamic phenomena which occur in reality. The determination of the accumulation of the gas main is just as important from a practical point of view. The authors deal with new theoretical possibilities of considering the effect of the non-steady state of flow upon the coefficient of the gas-dynamic resistance. The calculations suggested are not difficult in practice. The mathematical formulation of the gas-dynamic resistance may be expressed by means of the following system of Eq.:

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$$\left.\begin{aligned} &\rho\frac{dw}{d\tau} = -\frac{\partial p}{\partial z} + \frac{2\tau_0}{r_0}; && \text{(a)}\\ &\frac{\partial\rho}{\partial\tau} + \frac{\partial}{\partial z}(\rho w) = 0; && \text{(b)}\\ &dq = di + Ad\left(\frac{w^2}{2}\right); && \text{(c)}\\ &\frac{p}{\rho} = RTz && \text{(d)} \end{aligned}\right\} \quad (1)$$

If both sides of Eq. (1a) are multiplied with $d\tau$ and then integrated from 0 to θ, Eq. (2) is obtained and the values contained therein are defined by (3). θ is the time average.

$$\beta_w \rho \frac{dw}{d\tau} = -\frac{\partial p}{\partial z} + \frac{2}{r_0}\bar{\tau}_0 . \qquad (2)$$

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$$\bar{p} = \frac{1}{\Theta}\int_0^\Theta p\,d\tau; \quad (a)$$

$$\bar{w} = \frac{1}{\Theta}\int_0^\Theta w\,d\tau; \quad (b)$$

$$\bar{\rho} = \frac{1}{\Theta}\int_0^\Theta \rho\,d\tau; \quad (c)$$

$$\bar{\tau}_0 = \frac{1}{\Theta}\int_0^\Theta \tau_0\,d\tau; \quad (d)$$

$$\beta_\theta = \frac{\frac{1}{\Theta}\int_0^\Theta \rho\frac{dw}{d\tau}\,d\tau}{\rho\frac{dw}{d\tau}}. \quad (e)$$

(3)

After further calculations

$$\beta_{\text{м}}\,\rho w\,dw = -dp - C_{f,\text{мгн}}\,\frac{\rho w^2}{2}\cdot\frac{dz}{D} \qquad (8)$$

is finally obtained. An average can also be obtained in a similar manner for Eq. (1c):

$$dq = d\bar{i} + A\beta'_{\text{м}}\,d\left(\frac{\bar{w}^2}{2}\right). \qquad (9)$$

$$\left.\begin{aligned} &\bar{q} = \frac{1}{\Theta}\int_0^{\Theta} q\,d\tau; && \text{(a)}\\ &\bar{i} = \frac{1}{\Theta}\int_0^{\Theta} i\,d\tau; && \text{(b)}\\ &\beta'_{\text{м}} = \frac{\frac{1}{\Theta}\int_0^{\Theta} d\left(\frac{w^2}{2}\right)d\tau}{d\left(\frac{\bar{w}^2}{2}\right)} \cong \frac{\frac{1}{\Theta}\int_0^{\Theta}\frac{w^2}{2}\,d\tau}{\frac{\bar{w}^2}{2}}. && \text{(c)}\end{aligned}\right\} \qquad (10)$$

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Subsequently, Eq. (1b) is integrated with respect to z and $\varrho \bar{w} \int_z^0 (\partial\varrho/\partial\tau)dz = f(\tau)$ (11) is obtained. After multiplying at both sides with πr_0^2, and then with $d\tau$, integration from 0 to Θ,

$$\bar{G} = \frac{1}{\Theta}\int_0^\Theta G_\tau\, d\tau = \frac{1}{\Theta}\int_0^\Theta \pi r_0^2 f(\tau)d\tau = \text{const.} \qquad (13)$$

is obtained. Since, however $\bar{G} = \overline{\varrho w S}$, $\overline{\varrho w S} = \text{const.}$ (14). Finally $\bar{p}/\varrho = R\bar{T}\bar{z}$ (15) is substituted in (1d) for the period of the average. On the basis of (8), (9), (14), and (15), the gas-dynamic resistance at non-steady gas flow in the pipe line may be expressed by the following system of equations:

$$\beta_н \rho d\left(\frac{\bar{w}^2}{2}\right) = -d\,\bar{p} - C_{f,\,нсж}\frac{\rho w^2}{2}\cdot\frac{dz}{D}; \qquad (a)$$

$$\bar{\rho}\,\bar{w}S = \text{const.} \qquad (b)$$

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$$d\bar{q} = d\bar{i} + A\beta_w' d\left(\frac{\bar{w}^2}{2}\right); \quad \text{(c)}$$

$$\frac{\bar{p}}{\rho} = RTz. \quad \text{(d)} \qquad (16)$$

The system (16) differs from the solution of the previous paper of the authors (Ref. 1) in-so-far as the equations of motion and energy contain the constant coefficients β_σ and β_ω' for the given average. To determine the effect of the non-steady state of the gas flow upon the coefficient of the gas-dynamic resistance, the solutions for the steady gas flow are used and a corresponding correction β_0 is made for the inert term, and, instead of p_0 and p_1 their average values are substituted in the chosen period of time Θ. In the following the authors give examples which show that the non-steady state depending on the change of velocity in time may both increase and reduce the effect of the inert term and the coefficient of the gas-dynamic resistance. Only in the special case when $\beta_\sigma = 1$, the operational conditions of the gas main are analogous to the conditions

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prevailing at a steady flow with respect to the effect of the inert term. The coefficient β_Θ may be determined as follows: First a diagram is plotted of the change of w as a function of time, and then the differential quotient $\frac{dw}{d\tau}$ is determined by graphical differentiation. Below the diagram, the dependence $\varrho = \varrho(\tau)$ is graphically represented. The ordinates of the former diagram are multiplied with the ordinates of the latter and thus the quantity $\varrho\frac{dw}{d\tau}$ is found. On the basis of the last curve, $\int_0^\Theta \varrho\frac{dw}{d\tau}d\tau$ is found by graphical integration. The average quantities ϱ and $\frac{dw}{d\tau}$ are obtained from the diagrams $\frac{dw}{d\tau} = f(\tau)$ and $\varrho = \varrho(\tau)$ by way of graphical integration. On the basis of these data it is not difficult to obtain β_Θ. The methods shown are also applied by the authors to determine the accumulating capacity of the gas mains. Thus, accumulation for the period τ is expressed by the

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equation $G = (G_0 - G_\tau)\Theta$ (21) and the total accumulative power by $G = G_0\Theta_1$ (22). There are 3 Soviet-bloc references.

ASSOCIATION: Kuybyshevskiy industrial'nyy institut im. V. V. Kuybysheva (Kuybyshev Industrial Institute imeni V. V. Kuybyshev). Kuybyshevskiy aviatsionnyy institut (Kuybyshev Aviation Institute)

SUBMITTED: April 23, 1960

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KUDRYASHEV, L.I.; GOLOVIN, V.M.

Stability of the laminar flow of a viscous dripping liquid in circular cylindrical pipes. Izv. vys. ucheb. zav.; neft' i gaz 4 no.3: 107-112 '61. (MIRA 16:10)

1. Kuybyshevskiy industrial'nyy institut im. V.V.Kuybysheva.

KUDRYASHEV, L.I.; LYAKHOV, V.K.

Considering the effect of a longitudinal nonisothermal layer on the coefficient of heat transfer under inner problem conditions. Izv.vys.ucheb.zav.; av.tekh. 4 no.4:104-110 '61. (MIRA 15:2)

1. Kuybyshevskiy aviatsionnyy institut, kafedra aerogidrodinamiki.
(Heat--Transmission)

27550
S/170/61/004/010/003/019
B109/B125

24.5200

AUTHORS: Kudryashev, L. I., Smirnov, A. A.

TITLE: The effect of unsteady heat transfer on the coefficient of heat transfer between a streamed-at solid and the flow

PERIODICAL: Inzhenerno-fizicheskiy zhurnal, v. 4, no. 10, 1961, 21 - 29

TEXT: An infinitely long cylinder standing in the z direction is assumed to be subjected to an external cooling flow in the x direction. At the instant $T = 0$ the cylinder is supposed to be immersed infinitely fast into the flow. An unsteady heat transfer between cylinder and liquid begins at this moment. The authors base their theoretical investigations on the general flow equations and on the law of the increase of the turbulence $L = \sqrt{2\pi\nu t}$ which was established by Academician L. I. Sedov (Metody podobiya razmernosti v mekhanike, 1954). The heat transfer coefficient is found to be

$$\alpha = \frac{2\sqrt{\pi c}}{\pi} \frac{t_{1max}}{\vartheta_w} c_{po} \gamma_o W_o \sqrt{\nu\tau + \frac{x}{W_o}\nu} \qquad (23),$$

where t_{1max} denotes the maximum temperature in the middle of the wake

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The effect of unsteady...

$(y = 0)$, c_{po} and γ_o are the values of c_p and γ in the undisturbed flow, W_o is the undisturbed flow rate, $c = W_{x1max}x/bW_o$, W_{x1max} indicates the maximum velocity in the middle of the wake, and b is the breadth of the wake. For Pr = 1, Eq. (23) goes over into

$$Nu^2 = \frac{4c}{\pi}\left(\frac{t_{1max}}{\vartheta_w}\right)^2 FoRe^2 + \frac{4c}{\pi}\left(\frac{t_{1max}}{\vartheta_w}\right)^2 \frac{x}{d} Re \qquad (24).$$

Since $(t_{1max}/\vartheta_w)^2 x/d = \varphi_1(Re)$ and $(t_{1max}/\vartheta_w)^2 = \varphi_2(Fo,Re)$, one obtains from Eq. (24) $Nu^2/Nu^2_{st} = 1 + c/Fo^n Re^m$ (27), which is particularly convenient for experimental investigations. These investigations were carried out as follows: A 36 mm thick and 192 mm long duraluminium cylinder was heated to 180°C, and was then placed into an air stream. Temperature was measured by means of thermocouples. Fig. 1 shows the change of the cooling rate (1/sec) as a function of time (sec). Nu^2/Nu^2_{st} versus $FoRe^{0.7}$ is rendered in Fig. 3. $Nu^2/Nu^2_{st} = 1 + 3.6/(FoRe^{0.7})^{0.55}$ is obtained for $0 < FoRe^{0.7} < 23$ and $Nu^2/Nu^2_{st} = 1 + 282(FoRe^{0.7})^2$ for $23 < FoRe^{0.7} < 70$.

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27550
S/170/61/004/010/004/019
B109/B125

The effect of unsteady...

These results are in good agreement with the calculated values. Mention is made of B. D. Katsnel'son and F. A. Timofeyeva ("Teploperedacha i aerogidrodinamika", kniga 12, vyp. 3, Mashtiz, 1949; "Kotloturbostroyeniye" no. 5, 1948), and of Ye. M. Minskiy ("Izv. AN SSSR", 28, no. 8, 1940). There are 4 figures and 10 references: 9 Soviet and 1 non-Soviet.

ASSOCIATION: Aviatsionnyy institut, g. Kuybyshev (Aviation Institute, Kuybyshev)

SUBMITTED: April 28, 1961

Card 3/3

S/196/62/000/010/023/035
E073/E155

AUTHORS: Kudryashov, L.I., and Temnikov, A.V.

TITLE: On a solution of nonlinear problems of nonsteady-state heat-transfer on electric network integrators

PERIODICAL: Referativnyy zhurnal, Elektrotekhnika i energetika, no.10, 1962, 4, abstract 10 G22. (Tr. Kuybyshevsk. aviats. in-t, no.12, 1961, 41-53)

TEXT: The development of a method of successive intervals is proposed which is applicable to solving nonlinear symmetrical problems of nonsteady-state heat-exchange in a cylinder and a sphere. The method has great importance in simulation on models. The solution of the nonlinear problems of nonsteady-state heat-transfer on electric network integrators is considerably simplified by introducing the function [illegible] instead of the excess temperature. Solutions carried out on the electric integrator [illegible]-12 (EI-12) confirmed the results obtained by simulating the heat-transfer conditions on the [illegible]-5 (IPT-5) model.
13 references.

[Abstractor's note: Complete translation.]

Card 1/1

S/124/62/000/010/012/015
D234/D308

AUTHORS: Kudryashev, L. I., Bochkarev, A. F. and Turapin, V.M.

TITLE: Application of the theory of thermal regularity to the experimental determination of heat loss coefficient of bodies placed in an external flow

PERIODICAL: Referativnyy zhurnal, Mekhanika, no. 10, 1962, 97, abstract 10B604 (Tr. Kuybyshevsk. aviats. in-t, 1961, no. 12, 77-81)

TEXT: On the basis of the results of numerical calculations which are not given in the paper, the authors conclude that a differential equation of parabolic type (both linear and nonlinear) has the property of thermal regularity irrespective of the particular problem given. They give no due justification for such a conclusion in the paper. Experimental methods of determining the heat loss coefficient of a body in a stream, based on the above conclusion, are considered. [Abstracter's note: Complete translation.]

Card 1/1

S/124/62/000/010/011/015
D234/D308

AUTHORS: Kudryashev, L. I. and Shchibrayev, Ye. V.

TITLE: Application of the generalized theory of thermal regularity to the determination of the heat loss coefficient of complex bodies in air streams

PERIODICAL: Referativnyy zhurnal, Mekhanika, no. 10, 1962, 97, abstract 10B603 (Tr. Kuybyshevsk. aviats. in-t, 1961, no. 12, 83-92)

TEXT: The authors give an analytical proof of the existence of thermal regularity for a multilayer cylinder whose thermal conductivity and heat loss coefficients depend on temperature. Without corresponding specifications, the authors take the equations for a multilayer plate instead of those for a cylinder. Theoretical results are compared with experimental data in an example. [Abstracter's note: Complete translation.]

Card 1/1

S/196/62/000/010/017/035
E073/E155

10.3400

AUTHORS: Kudryashov, L.I., and Makarov, Yu.I.

TITLE: Theory of the resistance and heat transfer in jet flows past bodies

PERIODICAL: Referativnyy zhurnal, Elektrotekhnika i energetika, no.10, 1962, 2-3, abstract 10 G12. (Tr. Kuybyshevsk. aviats. in-t, no.12, 1961, 93-98)

TEXT: The principal difference in the physical picture of the flow past bodies by an unlimited flow and by a flow with finite dimensions was established. Differential equations analysed by similarity theory methods yield a new determining parameter x/θ which is of considerable importance in experimental determination of the resistance and heat-transfer coefficients in jet flow past bodies. The theory of the "regular thermal regime" serves to establish an unequivocal relation between the Nusselt criterion characterizing the external heat transfer and the new invariant K, which determines the internal process of heat conductivity. A simple method of applying the hydrodynamic

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Theory of the resistance and heat ... S/196/62/000/010/017/035
E073/E155

theory of heat exchange for the case of jet flows past bodies is proposed.
2 references.

[Abstractor's note: Complete translation.]

VB

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S/196/62/000/010/016/035
E073/E155

AUTHORS: Kudryashov, L.I., and Safonov, S.F.

TITLE: Coefficient of heat transfer and resistance during flow of a stream past an unlimited barrier

PERIODICAL: Referativnyy zhurnal, Elektrotekhnika i energetika, no.10, 1962, 2, abstract 10 G11. (Tr. Kuybyshevsk. aviats. in-t, no.12, 1961, 106-111)

TEXT: The physical features relating to the mechanical and thermal effects of a stream of finite dimensions on infinite barriers are considered. Since the relation between the speed and temperature is non-explicit, the dimensional method serves to demonstrate the characteristic similarity invariance. On the basis of this method, recommended functional relations are obtained for Nu_o and C_x. 3 references.

Abstractor's note: Complete translation.

Card 1/1

S/196/62/000/010/014/035
E073/E155

AUTHORS: Kudryashev, L.I., and Gusev, I.A.

TITLE: Influence of the high-speed non-steady state unlimited flow and a jet of finite dimensions on the resistance coefficient and the heat exchange in flow past bodies

PERIODICAL: Referativnyy zhurnal, Elektrotekhnika i energetika, no.10, 1962, 2, abstract 10 G8. (Tr. Kuybyshevsk. aviats. in-t, no.12, 1961, 113-117)

TEXT: The principal difference between a non-steady state stream and an unlimited flow past bodies is explained. An attempt is made to apply the hydrodynamic theory of heat exchange to the cases of an unlimited flow and streams under non-steady state conditions past bodies. If proposed experimental investigations are successful, the obtained theoretical assumptions could be applied for determining the heat-transfer coefficient and the resistance under non-steady state flow conditions.
3 references.
Abstractor's note: Complete translation.

Card 1/1

S/196/62/000/010/022/035
E073/E155

AUTHORS: Kudryashev, L.I., and Lyakhov, V.K.

TITLE: Influence of transverse and longitudinal non-isothermal conditions on the heat-transfer coefficient during turbulent flow of liquids in tubes of circular cross-section

PERIODICAL: Referativnyy zhurnal, Elektrotekhnika i energetika, no.10, 1962, 3, abstract 10 G17. (Tr. Kuybyshevsk. aviats. in-t, no.12, 1961, 145-154)

TEXT: Analysis of hydrodynamic and heat-transfer differential equations and thermal equilibrium equations shows that existing experimental data on heat transfer have to be considered as a particular case of small longitudinal temperature drops. Experimental data on heat transfer within a wide range of longitudinal non-isothermal conditions should include criteria which take into consideration the relations between the longitudinal and transverse temperature gradients. Theoretical conclusions are in fair agreement with experiment on heating liquids with various values of this temperature criterion. 7 references.

Card 1/1 [Abstractor's note: Complete translation.]

S/262/62/000/023/005/011
E194/E155

AUTHORS: Kudryashev, L.I., and Kopotev, A.A.

TITLE: A theoretical and experimental investigation of the influence of steadiness on the process of outflow from convergent nozzles

PERIODICAL: Referativnyy zhurnal, otdel'nyy vypusk, Silovyye ustanovki, no.23, 1962, 29, abstract 42.23.140. (Tr. Kuybyshevsk. aviats. in-t, no.12, 1961, 199-222)

TEXT: In designing and operating pulsating gas-turbine chambers theoretical and experimental investigations are required of the process of outflow from the nozzle under pulsating flow conditions. The theoretical part of the work formulates the problem of unsteady motion of gas in the nozzle and gives expressions for the rate of outflow and instantaneous dynamic impulse. Tests were made to check the main theoretical propositions and conclusions and also to assess the influence of the assumptions that were made. Pulsating flow was set up at the nozzle inlet by a single-cylinder piston engine. Three series of tests were made. The first studied the influence of nozzles of

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A theoretical and experimental ... S/262/62/000/023/005/011
E194/E155

different diameter on the gas conditions in the cylinder of the piston engine. The second series involved determination of the gas impulse beyond the nozzle and calculation of the flow factor in the gas ducts. The third series elucidated various problems associated with the physical nature of the processes. The experimental equipment is described in detail and also the system of measuring static pressure (pneumo-electric stroboscopic indicator) and the force impulse beyond the nozzle (impulse meter). The tests confirmed the conclusions of the theoretical investigations (in particular, the instantaneous rate of flow under pulsating flow conditions was greater than under steady-state conditions).
7 figures. 12 references.

[Abstractor's note: Complete translation.]

39790
S/147/62/000/002/018/020
E194/E435

26 5000

AUTHORS: Kudryashev, L.I., Gusev, I.A.

TITLE: The influence on the heat transfer coefficient of velocity pulsations of an unbounded flow over a body

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Aviatsionnaya tekhnika, no.2, 1962, 152-158

TEXT: When flow over a body is pulsating, heat transfer depends on the relationship between the period of pulsation and the time required to form a boundary layer. It is calculated that with a sphere 71 mm diameter in a flow of 9 to 17.6 m/sec, the longest time for the boundary layer to form is 1.55 m sec, which is much less than the least pulsation period used, namely 59 m sec. Under these conditions expressions can be derived which are in effect the ordinary boundary layer equations into which are substituted the corresponding values of velocity, pressure, temperature and density. By taking time averaged values the resistance and heat transfer problems in pulsating flow are formulated in a system of equations. The additional terms that

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S/147/62/000/002/018/020
E194/E435

The influence on the heat ...

correspond to pulsation indicate that, depending upon the conditions, pulsation may either increase or decrease heat transfer. The integral relationship method was applied to the case of a turbulent boundary layer to obtain the following functional relationship

$$\bar{Nu} = C Re_*^{n_1} Pr^{n_2} f \cdot (Ho_*). \quad (20)$$

where n_1 and n_2 are respectively the exponents of the Re and Pr numbers in the following expression

$$Nu = C\bar{Re}^{\frac{(1-n)(1+3n)+4n^2}{(1+n)(1+3n)}} \cdot Pr^{\frac{2n}{1+3n}}, \quad (12)$$

$$C = \frac{\int_0^{\pi} F(\theta)\sin\theta d\theta}{\int_0^{\pi} \sin\theta d\theta}. \quad (13)$$

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$$F(0) = \zeta \frac{\left(\frac{\bar{w}}{w_\infty}\right)^{\frac{1-n}{1+n}}}{f^{\frac{2n}{n}}}, \tag{14}$$

where $\bar{w}$ - the velocity at the outer edge of the boundary layer with flow over a sphere, w_∞ - the velocity with steady incident flow and ζ - a coefficient, equals 0.0225. Coefficient C and also n_1, n_2 and $f_1(Ho_\infty)$ should be determined by experiment. Wind tunnel tests undertaken for this purpose are described. The test results are satisfactorily represented by the following expression

$$\frac{Nu}{Nu_0} = 6{,}24\left(\frac{Ho}{Re}\right)^{1{,}8}. \tag{24}$$

where Nu - Nusselt's criteria for heat transfer in a pulsating flow; Nu_0 - applies to a steady flow. Eq.(24) may also be written in the following form

The influence on the heat ... S/147/62/000/002/018/020
E194/E435

$$Nu = 3.68\ Re^{0.405}\ Ho^{0.125} \qquad (25)$$

Analysis of the test results indicates that flow pulsation considerably increases heat transfer when the value of Re is less than 22000 when the ratio Nu/Nu_0 lies in the range 1.2 to 1.43. At Re above 22000, flow pulsation has practically no influence; if Re > 32000, pulsations may even reduce heat transfer. There are 4 figures.

ASSOCIATION: Kuybyshevskiy aviatsionnyy institut Kafedra aerogidrodinamiki (The Kuybyshev Aviation Institute, Department of Aerohydrodynamics)

SUBMITTED: April 20, 1961

KULYAPSHEV, I. I.; ZEPERIN, V. S.

Test determination of the effect of the nonstationary state of gas flow on the hydraulic-resistance factor. Izv. vys. ucheb. zav., neft' i gaz 5 no.11:89-93 '62. (MIRA 17:6)

1. Kuybyshevskiy aviatsionnyy institut i Kuybyshevskiy politekhnicheskiy institut imeni Kuybysheva.

S/152/63/000/003/005/005
B117/B186

AUTHORS: Kudryashev, L. I., Lyakhov, V. K.

TITLE: Experimental study of the heat exchange when heating a turbulent liquid flow in round tube

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Neft' i gaz, no. 3, 1963, 79-83

TEXT: The general character of the theoretical functions Nu = f(Pr) was experimentally confirmed for the heating of liquids. Based on the equation

$$Nu = CRe^n Pr^m \quad (1),$$

which according to previous statements (B. S. Petukhov, V. V. Kirillov, "Teploenergetika" no. 4, 1958; A. I. Kudryashev, Sb. nauchnykh trudov, no. 7, "Teplotekhnika". Kuybyshevskiy industrial'nyy institut, 1957) is sufficient for generalizing the experimental data, C and m were experimentally determined in the present work for the range Pr = 3- 300 with comparatively small changes of Re = 10^4 - 10^5. Diesel winter oil, diesel summer oil, and transformer oil were used for the experiments which were made according to a method described by V. L. Lel'chuk and

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Experimental study of the heat ... S/152/63/000/003/005/005
B117/B186

B. V. Dyadyakin ("Voprosy teploobmena", Izd-vo AN SSSR, 1959, p. 173-192). Experimental data found in publications for n-butyl alcohol and water were used for a more comprehensive generalization. The experimental data were evaluated by the method of successive approximation. The following ranges were found for which Eq. (1) can be used:

$Pr = 3 - 10$, $C = 0.023$, $m = 0.4$;
$Pr = 10 - 30$, $C = 0.0264$, $m = 0.352$;
$Pr = 30.0 - 100$, $C = 0.0316$, $m = 0.3$;
$Pr = 100 - 300$, $C = 0.0367$, $m = 0.264$.

The effect of the variability of physical parameters on the heat exchange $(\mu_f/\mu_w)^k$ could be objectively estimated during the experiments. In the range $Pr = 100 - 280$, k was found to be 0.16. This figure was higher than that found by other authors, which suggests a relation $k = f(Pr)$. Further experiments are necessary to study this dependence. There are 2 figures and 3 tables.

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Experimental study of the heat ... S/152/63/000/003/005/005
D117/D186

ASSOCIATION: Kuybyshevskiy aviatsionnyy institut
(Kuybyshev Aviation Institute);
Kuybyshevskiy politekhnicheskiy institut
(Kuybyshev Polytechnic Institute)

SUBMITTED: February 12, 1962

Card 3/3

KUDRYASHEV, L.I.

AID Nr. 997-5 11 June

DEPENDENCE OF HEAT TRANSFER COEFFICIENT ON LONGITUDINAL AND TRANSVERSE NONISOTHERMICITY IN TURBULENT FLUID FLOW (USSR)

Kudryashev, L. I., and V. K. Lyakhov. Inzhenerno-fizicheskiy zhurnal, no. 4, Apr 1963, 56-60. S/170/63/000/004/007/017

An analysis based on a two-boundary-layer model was made to derive generalized relationships for turbulent heat transfer, with allowance for transverse and longitudinal variations in physical properties. By introducing functions for mean thermal conductivity, viscosity, and specific heat into the equations for the laminar sublayer, the following expression, which allows for the effect of transverse nonisothermicity on heat transfer, was derived:

$$Nu_f = 0.023\, Re_f^{0.8}\, Pr_f^{0.48} \left(\frac{\mu_f}{\bar{\mu}}\right)^{0.32} \left(\frac{\bar{\lambda}}{\lambda_f}\right)^{0.52} \left(\frac{c_p \gamma}{c_{pf}\gamma_f}\right)^{0.32}$$

[f refers to bulk flow, μ = viscosity, λ = thermal conductivity, and γ = density]. Data calculated by the formula were in good agreement with previous experimental

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AID Nr. 987-5 11 June

DEPENDENCE OF HEAT TRANSFER COEFFICIENT [Cont'd] S/170/63/000/004/007/027

results obtained with viscous liquids at $Pr \gg 1$ and air at $Pr \approx 0.7$. The following formula was derived to express the effect of longitudinal isothermicity:

$$\theta = \frac{t' - t''}{t' - t_w} = c Re^n Pr^m \left(\frac{l}{d}\right)^k \left(\frac{\mu_f}{\mu_w}\right)^p,$$

where $t' - t''$ is the difference between inlet and outlet temperatures and t_w the mean wall temperature. Experimental data were correlated by this formula to within $\pm 8\%$, as compared with $\pm$ 15-20% obtainable by the empirical formula. The study was made at the Kuybyshev Aviation Institute. [PV

Card 2/2

Kuybyshev, ... ; Belkin, ...

Studies of complex heat exchange in the presence of variable thermophysical properties and radiant heat exchange

SOURCE: Tr. Kuybyshevsk. aviats. in-t, vyp. 15, ch. 2, 1963, 25-40

complex heat exchange, variable thermophysical properties, radiant heat

TRANSLATION: Three approaches are used in applying the theory of thermal regularity to studies of complex heat exchange. The first is stated in the form of the following principle: The constancy of the rate of cooling persists in the presence of variable thermo-... and radiant heat exchange ... excess is ... magnitude in a form ... equati... introduction of a new parameter ... excess

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ACCESSION NR: AR5000895

proves to be regular in relation to that parameter. The last approach is based on intro- ... efficient of complex heat exchange β. It was demonstrated experimentally that ... generalized ... of complex heat exchange ... data point ... experimental data. A simple ... heat exchange, employing the theory of ... which ... characteristic ...

TD ENCL: 00

Card 2/2

Elektrotekhnika i energetika, Abs. 80

Kitov, R. N.

heat-transfer coefficient under the conditions of an external

for chemical transformation

heat transfer, heat transfer coefficient

chemical-engineering processes associated with the heating of

the rate of reaction

ACCESSION NR: AR4049250

... of the reduced heat-transfer coefficient dependent on the ...

... data— ...

ENCL: 00

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